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NCAMP Material Specification

*This specification is generated and maintained in accordance with NCAMP
Standard Operating Procedures, NSP 100*

Medium Toughness Polyaryletherketone (PAEK) Thermoplastic
Toray (Formerly TenCate) Cetex® TC1225 Low Melt (LM) Polyaryletherketone
(PAEK) T700 Unidirectional 145 gsm 34% RC

Prepared by: Rachael Andrulonis (NCAMP/NIAR), Royal Lovingfoss (NCAMP/NIAR),
Vinsensius Tanoto (NCAMP/NIAR), John Tomblin (NCAMP/NIAR)

Reviewed by: Dan Leeser (Toray), Terry Hines (Toray), Benjamin Fox (Toray), Scott Unger
(Toray), Daniel Coyle (Toray)

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REVISIONS:

Rev	By	Date	Pages Revised or Added
N/C	Rachael Andrulonis, Royal Lovingfoss, Vinsensius Tanoto, John Tomblin	2/21/2020	Document Initial Release

1. SCOPE:

1.1 Form:

This detail specification along with the base specification NMS 122 establishes the requirements for continuous unidirectional carbon fiber impregnated with a Polyaryletherketone (PAEK) thermoplastic resin (“unidirectional tape prepreg”).

This detail specification follows the section and table numbering scheme of the base specification. It contains additional or superseding requirements. The base specification shall govern where no additional requirement is specified; in such cases, the applicable sections are omitted from this detail specification.

1.3 Classification: All products qualified to this detail specification have the following classification: Type 34, Class 1, Grade 145

2.7 Toray Publications:

PCD 053 Toray Advanced Composites Process Control Document, T700GC

3. TECHNICAL REQUIREMENTS:

Table 1 – Prepreg Physical and Chemical Properties (Class 1)

Property	Test Method ⁽¹⁾	Number of Replicates	Requirements ⁽⁴⁾
Resin Content	ASTM D3529	Each Batch ⁽²⁾	34±3% ind. 34±3% avg.
Fiber Areal Weight	ASTM D3776/D3766 M-09(a)2017 Option C or SACMA SRM 23R-94	Each Batch ⁽²⁾	145±7 gsm ind. 145±5 gsm avg.
Differential Scanning Calorimetry (DSC)	ASTM D3418 or SACMA SRM 25R-94	Each Batch ⁽³⁾	
Melt Temp. (Peak)			572 to 600 °F, ind. ⁽⁵⁾
Hot Crystallization Temp. (Peak)			426 to 483 °F, ind. ⁽⁵⁾

⁽¹⁾ Specific procedures should be identical to those used in the original material qualification program.

⁽²⁾ Three specimens minimum should be taken across the width of the prepreg batch.

⁽³⁾ Three specimens minimum should be taken for each prepreg batch.

⁽⁴⁾ “ind.” refers to individual measurements. “avg.” refers to the average measurements per roll.

⁽⁵⁾ Limits computed at α=0.01.

3.2 Constituent Material Requirements:

3.2.2 Reinforcement: Efforts to qualify the carbon fiber to NCAMP carbon fiber material specification, NMS 818, are ongoing. In the meantime, Toray will continue to provide aerospace-grade carbon fiber for this prepreg per the prepregger's carbon fiber procurement specification and Toray's internal aerospace-grade PCD. In addition, the following change control is implemented on the carbon fiber:

The carbon fiber tow product manufacturer shall establish control factors which will yield product meeting the technical requirements of this specification. The factors which are used in the production of fiber tow used in the prepreg material qualification shall constitute the approved factors; they shall be used for manufacturing production carbon fiber tow product. Control factors are Controlled Process Equipment and Controlled Process Parameters for producing the product. Control factors include, but are not limited to, the following:

- a) PAN Precursor formulation (raw ingredients and ratios),
- b) PAN Precursor manufacturing process, equipment, line, or site,
- c) PAN Precursor acceptance requirements,
- d) Carbon fiber tow processing parameters (e.g. temperature and speed),
- e) Carbon fiber tow manufacturing equipment, line, or site,
- f) Carbon fiber tow acceptance requirements,
- g) Carbon fiber tow acceptance test methods,
- h) Carbon fiber tow acceptance sampling plan,
- i) Carbon fiber tow surface treatment methods and levels,
- j) Carbon fiber tow sizing formulation and sizing level, and
- k) Carbon fiber tow sizing application and drying methods, including equipment.

If it is necessary to make any change in the above control factors, the carbon fiber tow product manufacturer shall submit for re-approval to NCAMP through the prepreg manufacturer in accordance with NRP 101 Prepreg Process Control Document (PCD) Preparation and Maintenance Guide. NRP 102 Polyacrylonitrile-based Carbon Fiber Process Control Document (PCD) Preparation and Maintenance Guide may be used as a reference. The change shall not be incorporated prior to the receipt of re-approval notice, typically in the form of a signed Advanced Change Notice (ACN).

3.4 Visual and Dimensional Requirements:

3.4.4 Roll characteristics - The standard width for this product is 12 inches. Other widths may be supplied only if it is specifically requested by the purchaser.

3.5 Consolidated Laminate Requirements:

3.5.2 Consolidated Laminate Physical Properties:

TABLE 2 – Consolidated Laminate Physical Properties (Class 1)

Property	Test Method ⁽¹⁾	Requirements ⁽²⁾
Consolidated Ply Thickness ⁽³⁾	ASTM D3171	0.0050 to 0.0060 inch, avg.
Laminate Density ⁽⁴⁾	ASTM D792	1.56 to 1.60 g/cc, avg.
Fiber Volume, by Volume ⁽⁴⁾⁽⁶⁾	ASTM D3171	55.0 to 62.0 %, avg.
Resin Content, by Weight ⁽⁴⁾⁽⁶⁾	ASTM D3171	31.0 to 37.0 %, avg.
Void Content, by Volume ⁽⁴⁾⁽⁶⁾	ASTM D3171	≤ 2%, avg.
Differential Scanning Calorimetry (DSC) ⁽⁴⁾	ASTM D3418 or SACMA SRM 25R-94	572 to 600 °F, ind. none ⁽⁵⁾ 426 to 483 °F, ind.
Melt Temp. (Peak)		
Cold Crystallization Temp. (Peak)		
Hot Crystallization Temp. (Peak)		

⁽¹⁾ Specific procedures should be identical to those used in the original material qualification program.

⁽²⁾ “ind.” refers to individual measurements. “avg.” refers to the average measurements per panel. Required only on one of the panels listed in Table 3.

⁽³⁾ Consolidated Ply Thickness of the Laminates in Table 4. Computed from actual qualification panel thicknesses using $\alpha=0.01$ and modified CV, and theoretical Consolidated Ply Thickness is set as the nominal.

⁽⁴⁾ Limits computed at $\alpha=0.01$.

⁽⁵⁾ Cold Crystallization should not be observed.

⁽⁶⁾ Fiber Density Nominal: 1.790 g/cc and Resin Density Nominal: 1.300 g/cc.

3.5.3 Consolidated Laminate Mechanical Properties:

TABLE 3 - Consolidated Laminate Mechanical Properties (Class 1)

Property	Test Method ⁽¹⁾	Requirements ⁽³⁾
0° Tension Strength and Modulus Room Temperature, Ambient Layup: [0] ₈	ASTM D3039	Strength ⁽²⁾ : Min. Ind. ≥ 245 ksi Strength ⁽²⁾ : Average ≥ 303 ksi Modulus ⁽²⁾ : 17.3 to 20.6 msi, avg.
90/0° Compression Strength and Modulus Room Temperature, Ambient Layup: [90/0] _{4s}	ASTM D6641	Strength ⁽²⁾ : Min. Ind. ≥ 77.1 ksi Strength ⁽²⁾ : Average ≥ 89.2 ksi Modulus ⁽²⁾ : 8.5 to 10.5 msi, avg.
90° Flex Room Temperature, Ambient Layup: [90] ₂₂	ASTM D790	Strength ⁽²⁾ : Min. Ind. ≥ 15.8 ksi Strength ⁽²⁾ : Average ≥ 18.8 ksi

⁽¹⁾ Specific procedures should be identical to those used in the original material qualification program.

⁽²⁾ Normalize the properties to a consolidated ply thickness value of 0.0054 inch, based on theoretical nominal CPT, using the following equation:
Normalized_Value = Measured_Value x Measured_CPT / Nominal_CPT

⁽³⁾ “ind.” refers to individual measurements. “avg.” refers to the average of 5 replicates. Limits computed at α=0.01 and modified CV.

QUALIFIED PRODUCTS LIST

Supplier Product Designation	Supplier Name and Production Location	Date Qualified	Specification Callout ⁽¹⁾
Toray Cetex® TC1225 Low Melt (LM) Polyaryletherketone (PAEK) T700GC 12K T1E Tape	Supplier Name: Toray (Formerly TenCate) Production Location: 18410 Butterfield Blvd Morgan Hill, CA 95037	2/21/2020	NMS 122/1 Classification callout is optional because Type 34, Class 1, Grade 145 is the only classification allowed in this QPL.

⁽¹⁾ In accordance with NCAMP Standard Operating Procedures, NSP 100, this QPL shall not contain alternate materials/products. Additional production location may be included in the QPL only after successful equivalency demonstration and approval per NCAMP Prepreg Process Control Document (PCD) Preparation and Maintenance Guide, NRP 101.

⁽¹⁾ The proper specification callout for material procurement purpose is “NMS 122/1.” This specification is developed based on the material properties that are available publicly. The purchaser may specify additional requirements beyond those specified in this specification, especially when the purchaser has generated additional material properties beyond those available publicly or when the application requires additional requirements. The additional requirements are subject to supplier review and approval.